Two-Dimensional Turbulence in Electromagnetically Forced Soap Films

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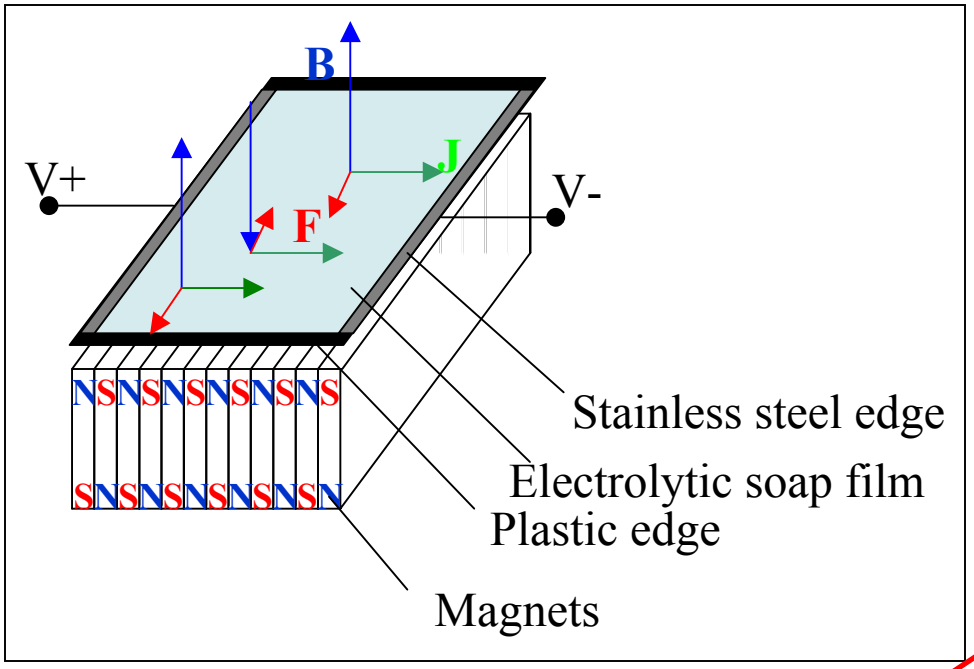
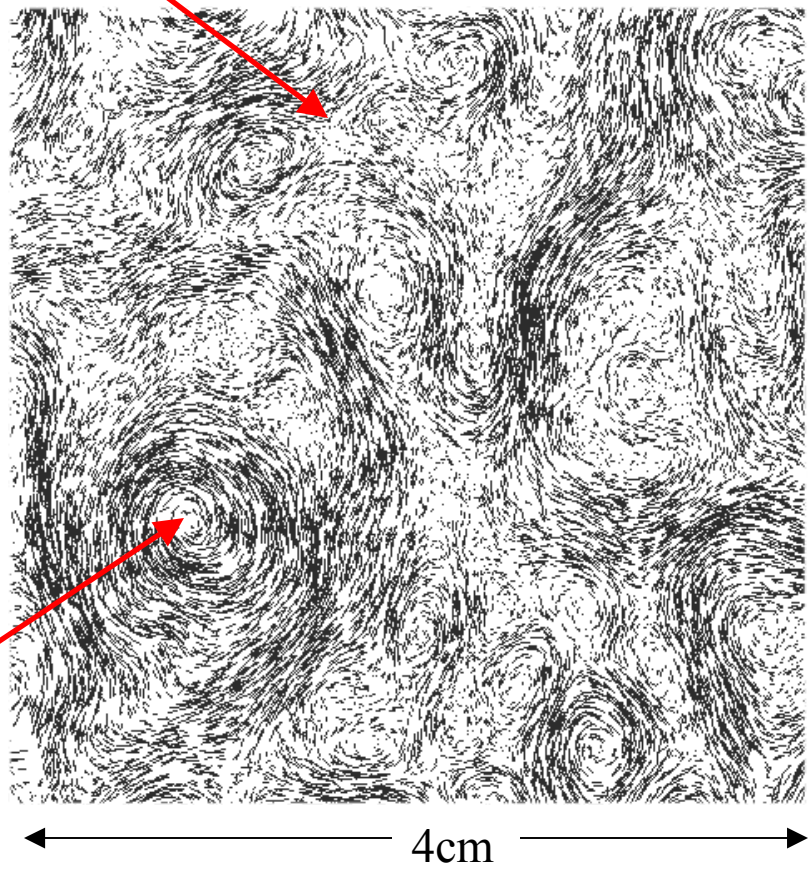
E-M Cell



- Cell size: 7×7 cm^2
- The applied voltage(72V) oscillates at 3Hz with a square wave

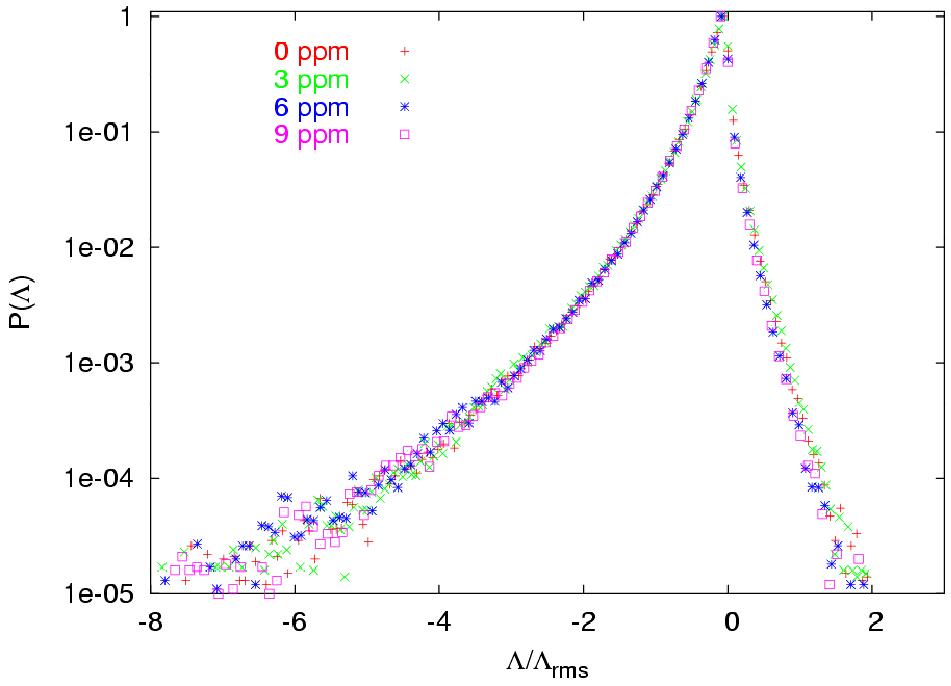
Velocity Field



Two-Dimensional Turbulence in the Presence of Polymers

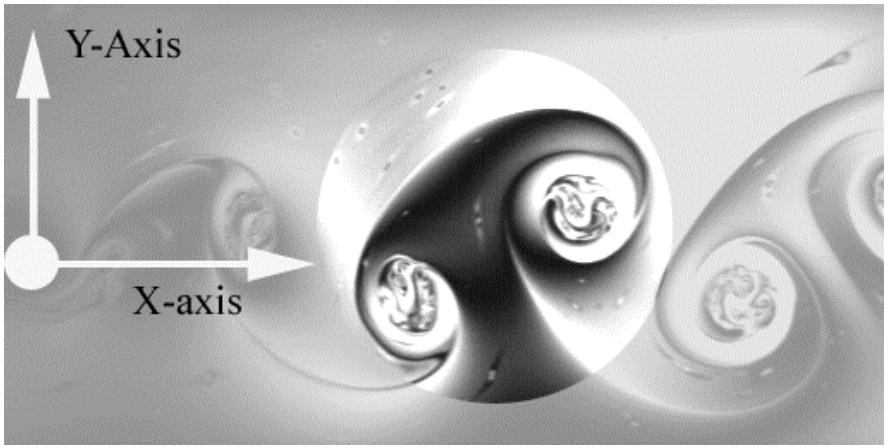
The flow of a Newtonian fluid is turbulent when the Reynolds number is sufficiently large. In contrast, viscoelastic fluids such as solutions of flexible long-chain polymers have nonlinear mechanical properties and therefore may be expected to behave differently.

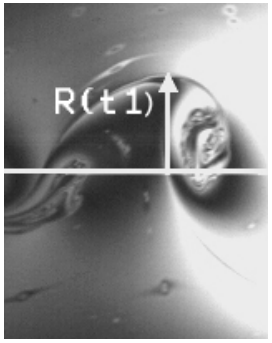
One of the most fascinating phenomena in turbulence is polymer drag reduction. We expect that the polymer will change the distribution of centers (vortices) and saddles (elongation) in the fluid. The centers (ω) and saddles (σ) can be described by the distribution function $P(\Lambda)$ where $\Lambda=(\omega^2-\sigma^2)/4$. We compared $P(\Lambda)$ in 2D turbulence with and without the polymer. Surprisingly no polymer effect has been observed.

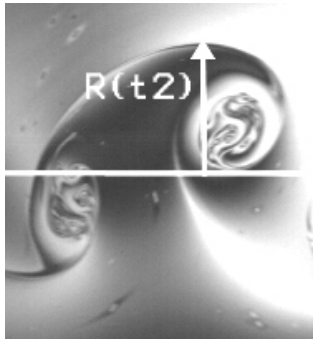


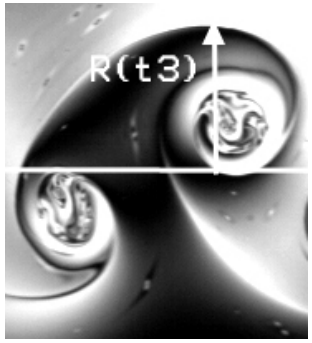
The distribution function $P(\Lambda)$ in two dimensional turbulence at different polymer concentration, 0, 3, 6, and 9 ppm respectively. The mass of polymer (PEO) is MW 8,000,000.

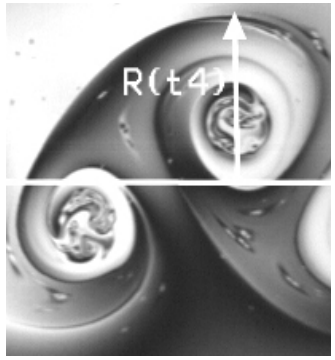
Von-Karman Vortex Street in 2D





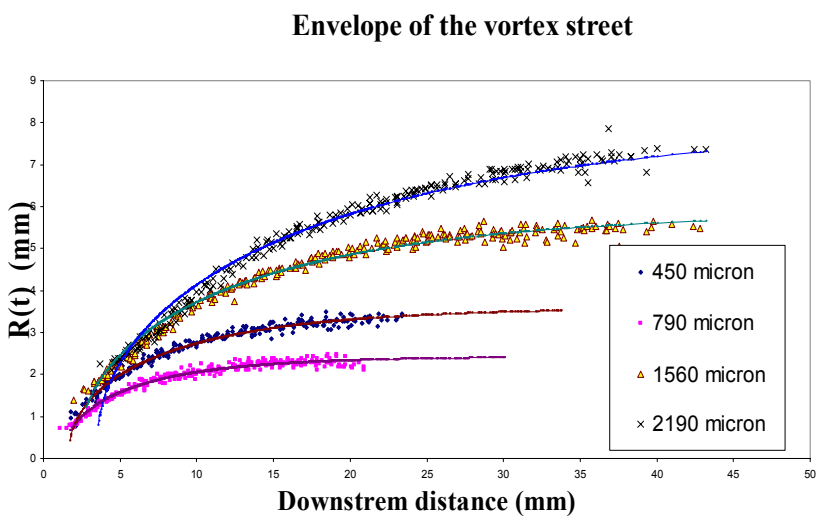


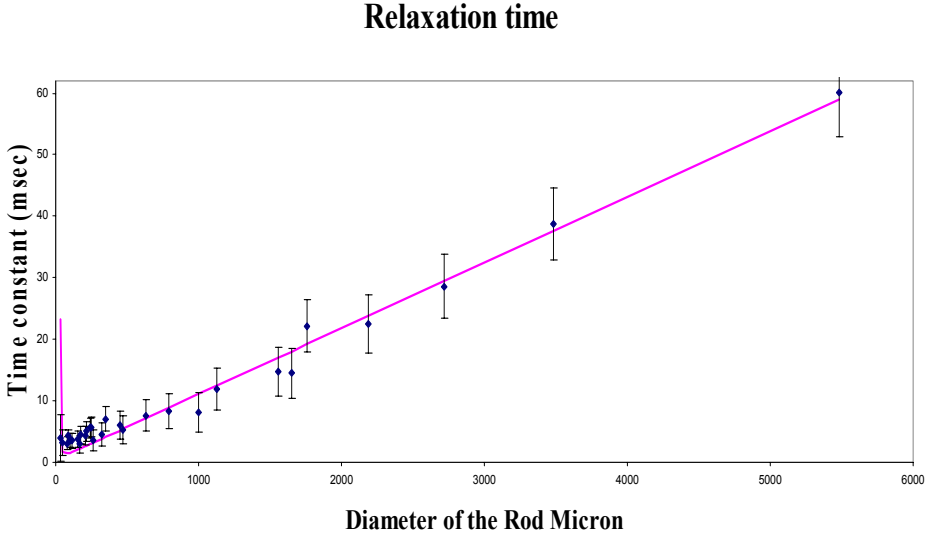


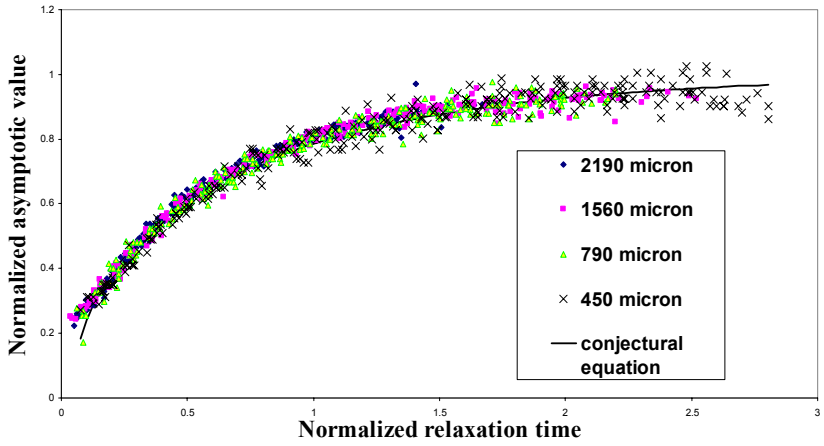


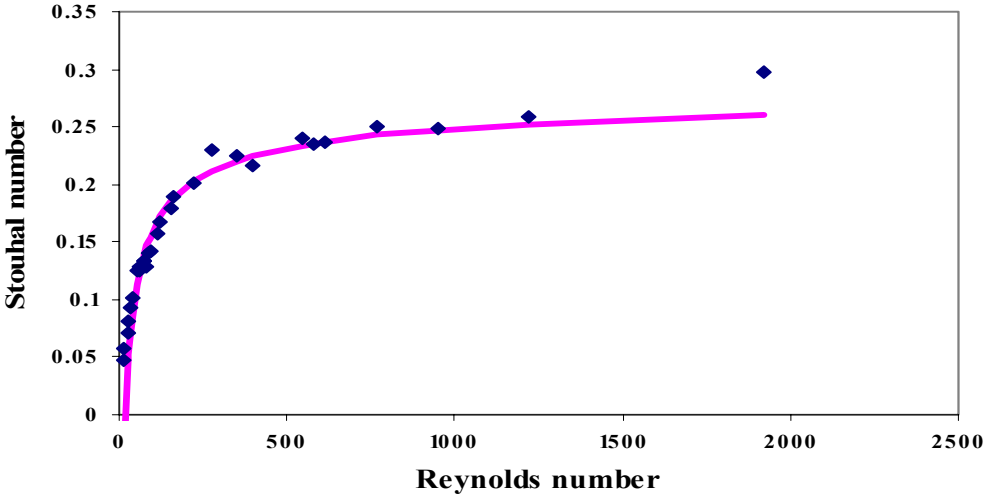
- **The envelope of the vortex street was measured by digitizing the image of the street at different locations downstream.**
- **Our results are remarkably different from those seen in 3D systems, suggesting that ours is the true 2D behavior.**

Universality of the Envelope of the Vortex Street









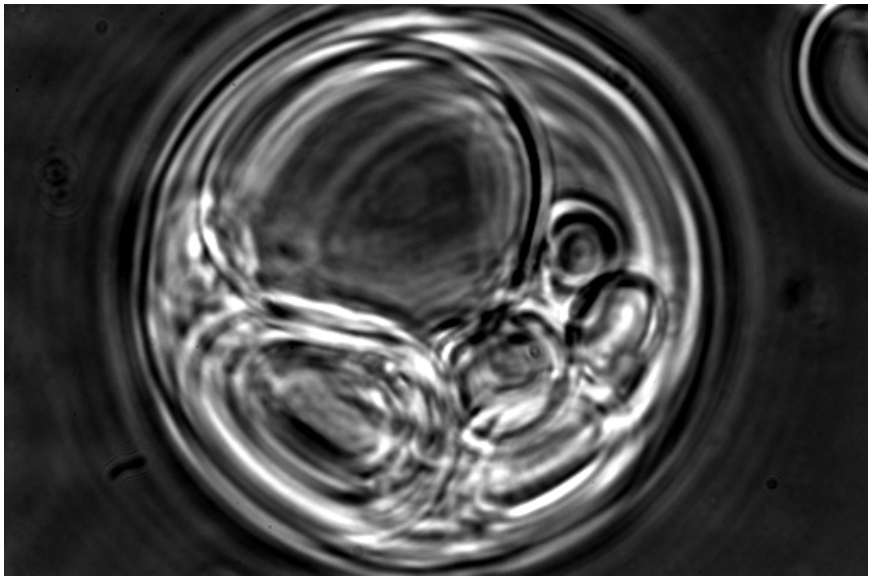
Top-left: The width of the envelope for different rod diameters. The solid lines show the fit.

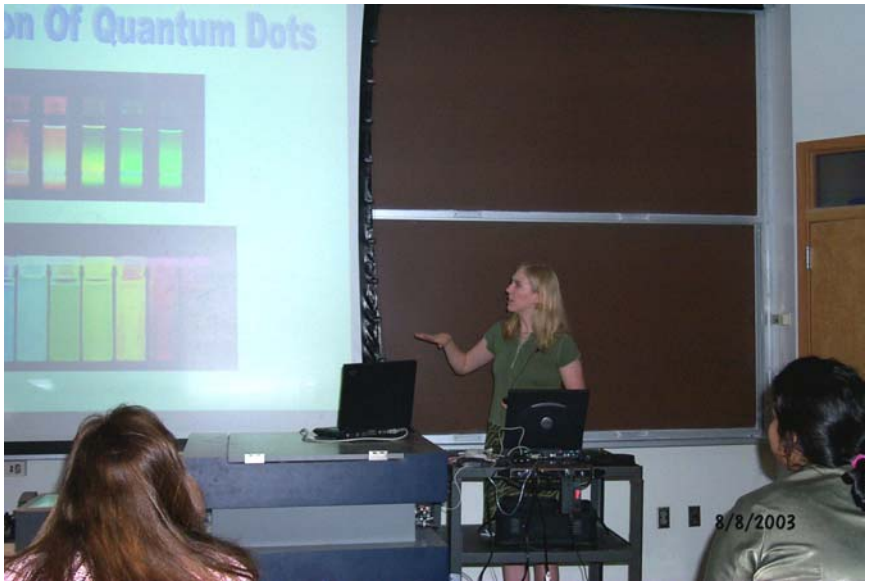
Bottom-left: Normalized envelopes.

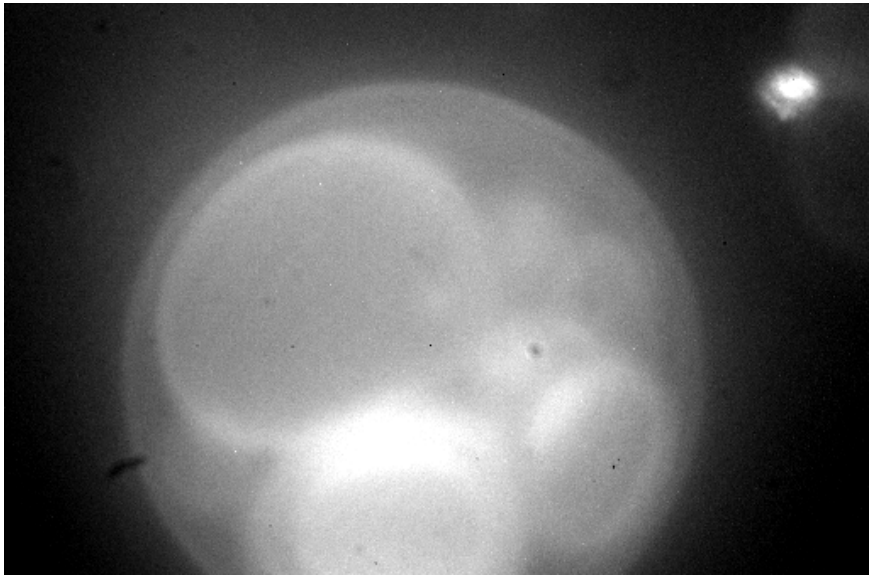
Top-right: Relaxation time for different rod diameters.

Bottom-right: Strouhal vs. Reynolds number. The fitting curve exploits $1/(Re)^{1/2}$ (Williamson's conjecture) instead of 1/Re (Lord Rayleigh's conjecture).

Outreach Program







- **Sarah Rugheimer, an REU student, gave the final presentation of her project on quantum dots. The two pictures on the left are phase contrast and fluorescent images of q-dot loaded vesicles.**
- **Also work with local high-school students on subjects such as waves, light and vision.**

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